Review of Computer Engineering Research
2018 Vol. 5, No. 1, pp. 12-19
ISSN(e): 2410-9142
ISSN(p): 2412-4281
DOI: 10.18488/journal.76.2018.51.12.19

SURVEY OF IMAGE PROCESSING BASED APPLICATIONS IN AMR

K.Karthick[1+]
M.Premkumar[2]
R.Manikandan[3]
R.Cristin[4]

[1]*Associate Professor, Department of EEE,GMR Institute of Technology, Rajam, India*
Email: kkarthiks@gmail.com
[2]*Assistant Professor, Department of EEE,GMR Institute of Technology, Rajam, India*
Email: mprem.me@gmail.com
[3]*Professor, Department of EIE, Panimalar Engineering College, Chennai, India*
Email: money_kandan2004@yahoo.co.in
[4]*Sr. Assistant Professor, Department of CSE,GMR Institute of Technology, Rajam, India*
Email: cristinsjce@gmail.com

(+ Corresponding author)

Article History
Received: 18 June 2018
Revised: 3 August 2018
Accepted: 31 August 2018
Published: 26 September 2018

Keywords
OCR
AMR
Automatic meter reading
Computer-human interaction.

ABSTRACT

The ability to use computer and human based interaction would make things easier for the user, but would be challenging for the researchers. More sophisticated imaging systems can handle inter plot the results of image analysis and describe the various objects and their connections in the scene. The electricity, gas, and water metering instruments may employ the Automatic meter reading (AMR) system for automation of bill generation process. The image processing implementation may ease the process of AMR. In this paper, we discussed the image processing applications in AMR.

Contribution/Originality: This study is one of very few studies which have investigated the applications of image processing in automatic meter reading.

1. INTRODUCTION

Digital image processing system is becoming popular due to easy availability of computers with large memory size, graphics based software tools, etc. Image processing finds various applications like film industry, forensic studies, remote sensing technology, medical imaging, military applications, text detection, printing industry, etc. The advent of image processing has registered an incredible and noble growth curve for the past two centuries. This improvement is very clearly shows that how computer science engineers and researchers alike, in the way interactions between man and machine have grown.

If continuous research in man-computer interaction makes ground-breaking achievements, the interactions with computers would increasingly seem like interactions that happen between people. Various techniques like speech recognition, bar code, and Optical Mark Recognition (OMR), and Optical Character Recognition (OCR) fulfill the automation needs in various applications [1]. So Image processing based automation has distinct application in AMR. Here we discussed the implementation of image processing based technology in AMR.

2. REVIEW ON IMAGE PROCESSING BASED APPLICATIONS IN AMR

2.1. OCR System for Seven Segment Display Images of Measuring Instruments

Ghugardare, et al. [2] propose a generalized module for automatic calibration of any measuring instruments (e.g. Temperature Monitoring System) using optical character recognition approach. The module is designed for scanning of seven segment display of measuring instruments through the camera. The System will preprocess the seven segment character display images and then extract the features for recognition. The following block diagram that is shown in Figure 1 shows the various stages involved in text recognition from seven segment display.

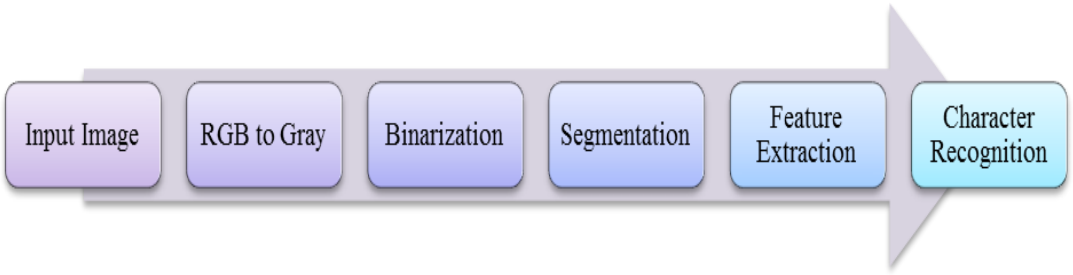

Fig-1. Various Stages Involved in Text Recognition

They mainly suggest algorithms for recognition of seven-segment display characters present on digital multi-meters. This solution benefits toward the significant reduction in work quantity for calibration as well as from better replication and objectivity of measuring. The accuracy of the system is 95%.

2.2. Automatic Recognition System for the Numeric Character on Ammeter Dial Plate

Li and Qian [3] proposed the image processing based automatic recognition system for the numeric character on ammeter dial plate. The recognition system uses the binary transformation, Hough transformation, projecting algorithm, thinning, closed and open algorithm as preprocessing stage, put forward nine segment display projection algorithm based on seven-segment display to extract the digital characteristics and use layered pattern base to realize numeric characters recognition. Figure 2 shows the flowchart of the text recognition process in Ammeter dial plate.

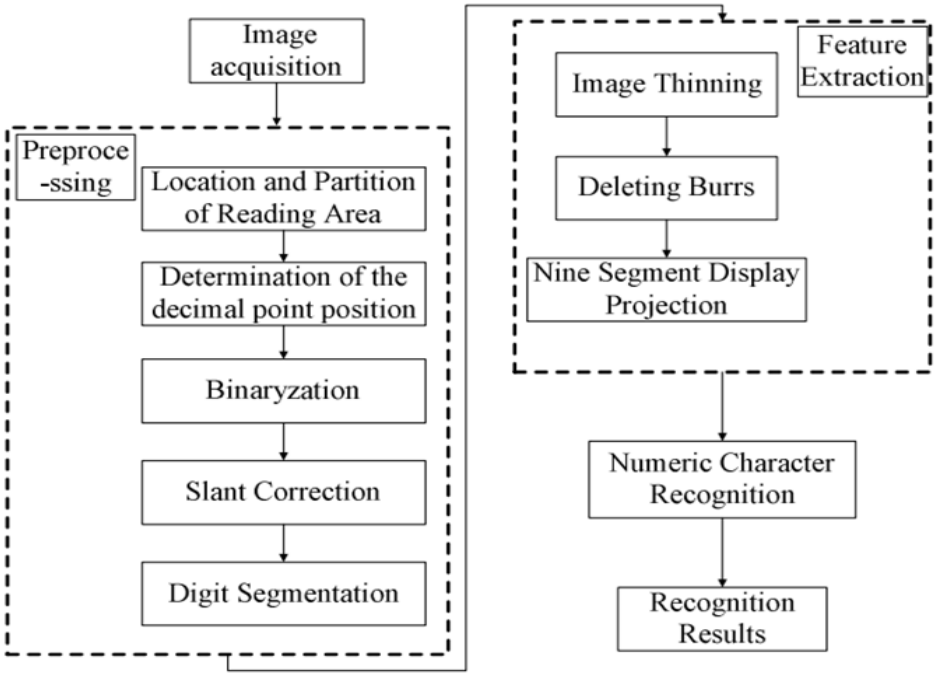

Fig-2. Flowchart of the Text Recognition in Ammeter dial Plate

Source: Li and Qian [3]

Characters similar in shape can be distinguished better by using nine-segment display projection algorithm. The experiment shows that the numeric character recognition rate is up to 98% and the recognition time of six digits mechanical ammeter is less than 18 milliseconds.

The electro-mechanical energy meters are commonly employed in the consumer doorsteps to measure the consumption of utilities. There exist two types of analog meters one type use rotary dials and the other one uses pointer dials.

Ocampo-Vega, et al. [4] introduce a methodology based on image processing and segmentation to enable the image acquisition and processing of pointer dials type energy meter to obtain efficient and accurate meter readings. The image acquired with a Smartphone and applied a sequence of image processing techniques to find and extract the pointer dial. The database created with more than a hundred of images. The images have been taken under different light conditions, angles and perspectives. The method can extract the reading information in an average of three seconds, with 92 % accuracy. The method enables the usage of the Smartphone to acquire and automatically extract the reading information of a pointer type analog dial meter. It allows interesting applications that could help the public to monitor their energy consumption and learn patterns to save energy.

Yudong, et al. [5] discuss to replace inaccuracy and time-consuming job of energy measurement by meter readers. The automatic reading of pointer-type energy meter can be realized with computer vision and image processing technology. It has the feature of higher efficiency, less consumption, and lower production costs. Zhao, et al. [6] put forward a novel method, which the power meter can be read based on computer vision, and the architecture of the remote meter automatic reading system is designed. The non-contact measurement method using computer vision technique has been proposed which is different with the AMR system that must obtain the value from the digital communication interface. The local meter reading information of distributed substation can be transmitted to the central server using computer network. The preprocessing, segmentation and pattern matching are the various steps in the meter image recognition process. Via energy meter automatic recognition experiment, the results based computer vision is accurate enough to monitor the remote substation running parameters.

The OCR technique is used to detect characters other than English, like Arabic [7] Chinese [8] Telugu [9] Tamil [10] etc. The various applications and works presented by various authors show that OCR helps to reduce the manual data entry work.

2.3. Automatic Gas Meter Reading

Vanetti, et al. [11] present a novel approach for automatic gas meter reading from the real world images. Like electricity meter reading, the gas meter reading is usually done manually by an operator, and a picture is taken from a mobile device as proof of reading. Since the reading operation is prone to errors, the proof image is checked offline by another operator to confirm the reading. The Figure 3 shows the results of various stages obtained by Vanetti, et al. [11].

Fig-3. Results of the novel approach for automatic gas meter reading from the real world image
Source: Vanetti, et al. [11]

They present a method to support the validation process to reduce the human intervention. Their approach is trained to detect and recognize the text of a particular area of interest. Initially, they detect the region of interest and segment the text contained using a method based on an ensemble of neural models. Then they perform an optical character recognition using a Support Vector Machine. They evaluated every step of their approach, as well as the overall assessment, showing that despite the complexity of the problem their method provides good results also when applied to degraded images.

2.4. Recognition of Seven Segment Numbers on Display

Kulkarni and Kute [12] discusses an algorithm for the recognition of seven segment numbers on display so that the algorithm can be utilized for applications such as the automated reading of LCD-based meters. The algorithm outlines a 7-step process consisting of four types of operations such as object detection, noise removal, image segmentation and numeral recognition based on pixel density feature extraction. Figure 4 shows the steps involved in the algorithm developed by

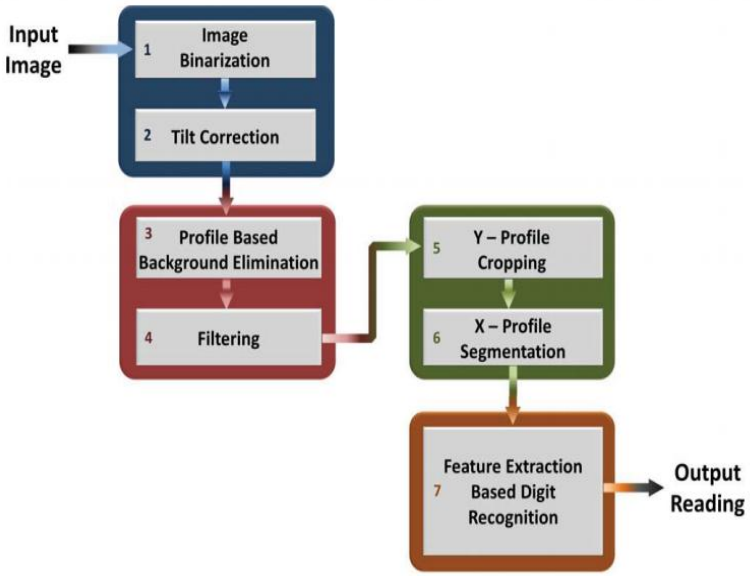

Fig-4. Steps Involved in the Proposed Algorithm for the Recognition of Seven Segment Numbers on Display
Source: Kulkarni and Kute [12]

The performance of the algorithm is evaluated, by simulation and field tests, for robustness to variations of digit positions, brightness, contrast, tilt, and noise. The recognition rate of the algorithm is 79% when tested over a wide range of variation in illumination and angular tilt conditions.

There has been an ongoing effort for increasing the number of AMI devices to improve the observability of the system. When deployed across secondary networks distribution, AMI provides the information of building-level load and energy consumption, which can be used to improve strategy of grid management. A barrier to implementation is the significant upgrade costs associated with retrofitting existing energy meters with network-capable sensing. The economical way is to use image processing methods to extract usage information from images of the current meters. Tang, et al. [13] present a solution without modifying the existing electromechanical analog meters. It uses online data exchange of energy consumption information from consumer premises to a central server. The systematic approach to extract energy consumption data from the images is applied to replace the existing process of manual reading.

2.5. LED Text Detection and Recognition

Nowadays, LED dot matrix has the increasing role in many application areas to showing messages and contents. These messages contain various characters to display the message. A single character can be displayed by a matrix containing a particular number of rows and columns. By combining the characters, any message can be shown on LED display board. The message shown with the help of LED is the LED text. The LED text is very hard to detect because it shows discontinuity.

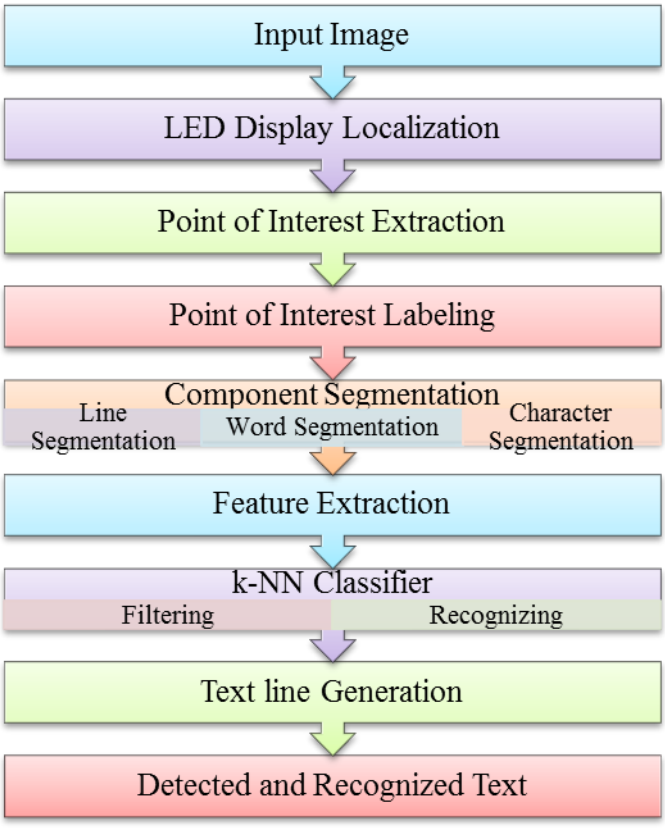

Fig-5. LED Text Detection and Recognition Process

Vandana and Kaur [14] proposed a method to solve the problem of LED text detection and recognition. They extract the board region from natural image to perform their method. The work is developed by firstly inputting an image. The input image is then processed to convert the colors to grayscale. Then, the image is segmented to extract the rectangular region. The single character detected with single character extraction method. They recognized the characters with 88.57% accuracy.

In recent years, the dot-matrix text of LED display is widely used for displaying the information. At present, there is no text extraction or recognition system that is capable of handling the LED text. Unlike the printed text, it is not the easiest job to detect or recognize the LED text due to its discontinuity in shape.

Wahyono and Jo [15] propose a method for text detection in LED display and recognition in images of the natural scene. The recognition process is consisting of two steps. The first step is to apply canny edge detector to detect the character pixels which appears in the LED display area.

The character feature extraction has been performed based on the spatial information like centroid and orientation of the character candidate. These values analyzed using a k-nearest neighbor algorithm for alphanumeric character classification. The recognized characters combined into a text line based on the similarity of their characteristics like aspect ratio, width, height, and colour. The post-processing is then applied for rectifying the falsely recognized characters. In experiments, the proposed method achieves 68.8% and 47% for text location detection and recognition rate, respectively. These results show the robustness and effectiveness of the proposed method for detecting and recognizing the LED text in natural scene images. The results of our previous work [16] OCR based Electricity billing has been shown in figure 6.

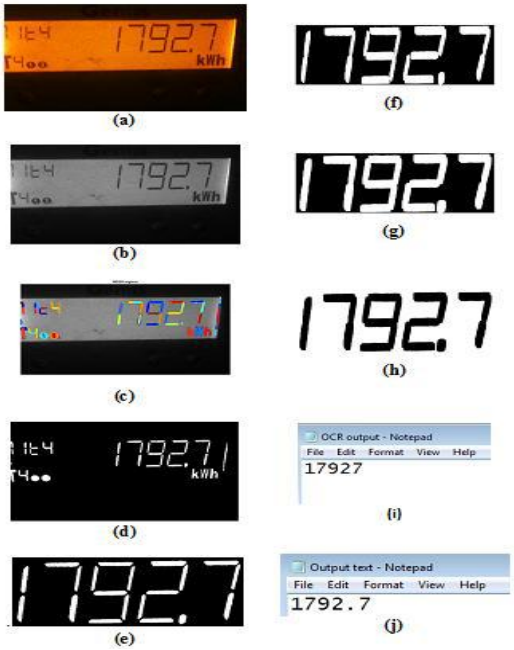

Fig-6. OCR Results (a) Original image sent by the consumer (b) Gray scale image (c) MSER regions (d) Binary mask (e) Cropped kWh image (f) & (g) Horizontal & Vertically dilated image (h) Complemented image (i) OCR function output (j) Final output

Source: Karthick and Chitra [16]

Rodriguez, et al. [17] discussed the necessity to develop tools that allow the consumers to know about their electricity consumption. They propose a new number recognition algorithm named as Hausdorff distance for meter reading (HD MR). The experiments prove that HD MR can achieve a 99.9% recognition rate, even when recognized numbers are under rotation in the energy meter. The maximum recognition time is 31 ms; hence, the proposed method proves to be efficient and capable in real time for the task proposed.

3. CONCLUSION

In today world, images place a significant role in the area of data mining. Superimposed text in images gives much information. Recognition of text in images is of greater demand. Text recognition in complex background images is still a very challenging task in computer vision. In this paper we discussed various techniques of image

processing that has been applied for AMR. The implementation of image processing helps us to build novel approach in automation.

Funding: This study received no specific financial support.
Competing Interests: The authors declare that they have no competing interests.
Contributors/Acknowledgement: All authors contributed equally to the conception and design of the study.

REFERENCES

[1] K. Weigelt, M. Hambsch, G. Karacs, T. Zillger, and A. C. Hubler, "Labeling the world: Tagging mass products with printing processes," *IEEE Pervasive Computing*, vol. 9, pp. 59-63, 2010.Available at: https://doi.org/10.1109/mprv.2010.37.

[2] R. P. Ghugardare, S. P. Narote, P. Mukherji, and P. M. Kulkarni, "Optical character recognition system for seven segment display images of measuring instruments," presented at the IEEE Region-10 Conference, TENCON 2009, Singapore, 2009.

[3] Y. Li and H. Qian, "Automatic recognition system for numeric characters on ammeter dial plate," presented at the 9th International Conference for Young Computer Scientists, Hunan, 2008.

[4] R. Ocampo-Vega, G. Sanchez-Ante, L. E. Falcón-Morales, and H. Sossa, "Image processing for automatic reading of electro-mechanical utility meters," presented at the 12th Mexican International Conference on Artificial Intelligence, Mexico City, 2013.

[5] G. Yudong, Z. Yang, H. Bowen, Z. Hong, and S. Dayu, "Pointer-type meter reading method research based on image processing technology," presented at the Second International Conference on Networks Security, Wireless Communications and Trusted Computing, Wuhan, Hubei, 2010.

[6] S. Zhao, B. Li, J. Yuan, and G. Cui, "Research on remote meter automatic reading based on computer vision," presented at the IEEE/PES Transmission & Distribution Conference & Exposition: Asia and Pacific, Dalian, 2005.

[7] S. Kanoun, A. M. Alimi, and Y. Lecourtier, "Natural language morphology integration in off-line Arabic optical text recognition," *IEEE Transactions on Systems, Man, and Cybernetics, Part B (Cybernetics)*, vol. 41, pp. 579-590, 2011.Available at: https://doi.org/10.1109/tsmcb.2010.2072990.

[8] Y. C. Wu, F. Yin, and C. L. Liu, "Evaluation of neural network language models in handwritten Chinese text recognition," presented at the 13th International Conference on Document Analysis and Recognition (ICDAR), Tunis, 2015.

[9] T. R. V. Lakshmi, P. N. Sastry, R. Krishnan, N. V. K. Rao, and T. V. Rajinikanth, "Analysis of Telugu palm leaf character recognition using 3D feature," presented at the International Conference on Computational Intelligence and Networks (CINE), Bhubaneswar, 2015.

[10] K. Karthick and S. Chitra, "A bilingual numeral OCR system for creating uni-lingual digitized numeral document," *Modern Applied Science*, vol. 9, pp. 148-153, 2015.Available at: https://doi.org/10.5539/mas.v9n13p148.

[11] M. Vanetti, I. Gallo, and A. Nodari, "GAS meter reading from real world images using a multi-net system," *Pattern Recognition Letters*, vol. 34, pp. 519-526, 2013.Available at: https://doi.org/10.1016/j.patrec.2012.11.014.

[12] P. H. Kulkarni and P. D. Kute, "Optical numeral recognition algorithm for seven segment display," presented at the Conference on Advances in Signal Processing (CASP), Pune, 2016.

[13] Y. Tang, C. Ten, C. Wang, and G. Parker, "Extraction of energy information from analog meters using image processing," *IEEE Transactions on Smart Grid*, vol. 6, pp. 2032-2040, 2015.Available at: https://doi.org/10.1109/tsg.2015.2388586.

[14] P. G. Vandana and B. Kaur, "A novel technique for LED dot-matrix text detection and recognition for non-uniform color system," presented at the International Conference on Advances in Computing, Communications and Informatics (ICACCI), Jaipur, 2016.

[15] Wahyono and K. Jo, "LED Dot matrix text recognition method in natural scene," *Neurocomputing*, vol. 151, pp. 1033-1041, 2015.Available at: https://doi.org/10.1016/j.neucom.2014.07.079.

[16] K. Karthick and S. Chitra, "Novel method for energy consumption billing using optical character recognition," *Energy Engineering: Journal of Association of Energy Engineers*, vol. 114, pp. 64-76, 2017.Available at: https://doi.org/10.1080/01998595.2017.11863765.

[17] M. Rodriguez, G. Berdugo, D. Jabba, M. Calle, and M. Jimeno, "HD MR: A new algorithm for number recognition in electrical meters," *Turkish Journal of Electrical Engineering & Computer Sciences*, vol. 22, pp. 87-96, 2014.Available at: https://doi.org/10.3906/elk-1202-34.